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Negative Pressure Wound Therapy for Closed Laparotomy Incisions in General and Colorectal Surgery

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ABSTRACT

Background: The literature on Negative Pressure Wound Therapy (NPWT) for closed laparotomy incisions in general and colorectal surgery reveals a significant advancement in understanding its efficacy and applications over the past decade. **Literature Review:** (Ousey et al., 2013) provide a foundational overview of NPWT devices, emphasizing their role in complementing standard medical care rather than replacing it. They advocate for a tailored approach to NPWT application, with optimal pressure settings varying according to patient demographics and clinical conditions. This individualized strategy is crucial for maximizing the benefits of NPWT in diverse surgical populations. (Borejsza-Wysocki et al., 2021) evaluate NPWT's impact on preventing surgical site infections (SSIs) after stoma reversal, suggesting that while NPWT may lower infection rates, results must be interpreted with caution due to statistical insignificance. Nonetheless, they emphasize NPWT's multifactorial mechanism of action in promoting optimal healing conditions. (Szabóné Révész et al., 2022) consolidate findings on NPWT's effectiveness across a range of wound types, highlighting its advantages such as enhanced blood flow and reduced bacterial load, critical factors for successful wound healing. (Wouters et al., 2022) and (Sato et al., 2022) reinforce the concept of prophylactic NPWT in preventing surgical site occurrences, particularly in high-risk surgeries. Their collective findings advocate for NPWT's integration into standard postoperative care protocols, aiming to mitigate complications like SSIs and seromas. **Conclusion:** In conclusion, the body of literature presents a compelling case for the application of NPWT in closed laparotomy incisions, emphasizing its evolving role in enhancing surgical outcomes. The evidence suggests that NPWT not only improves wound healing but also serves as a proactive measure in preventing complications, thereby informing future clinical practices in general and colorectal surgery.

Keyword: Negative Pressure Wound Therapy, Closed Laparotomy Incisions, General and Colorectal Surgery

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INTRODUCTION

The literature on Negative Pressure Wound Therapy (NPWT) for closed laparotomy incisions in general and colorectal surgery has evolved significantly over the past decade, reflecting a growing recognition of its potential benefits in postoperative wound management. The systematic review by Ousey et al. (Ousey et al., 2013) highlights the variety of NPWT devices available for managing closed surgical incisions at risk of complications, emphasizing that while NPWT can enhance wound healing, it should complement standard medical care rather than replace it. The authors note that optimal negative pressure settings vary based on patient demographics and conditions, suggesting a tailored approach to NPWT application.

In a similar vein, the study by 심홍진 et al. (et al., 2013) provides empirical evidence from a single-center experience with NPWT in patients experiencing wound dehiscence following abdominal surgery. Their findings underscore the efficacy of NPWT in promoting granulation formation and facilitating recovery, particularly in high-risk surgical populations. This work aligns with the earlier review, reinforcing the notion that NPWT can be a valuable tool in managing complex surgical wounds.

Nordmeyer et al. (Nordmeyer et al., 2015) further expand on the applications of NPWT, specifically focusing on its use in closed surgical wounds, including incisional NPWT (iNPWT) following severe trauma. They acknowledge that while the evidence base for iNPWT is still developing, there are promising indications of its efficacy in enhancing tissue perfusion and promoting angiogenesis, which are critical for optimal healing outcomes. This study adds to the understanding of NPWT's mechanisms, suggesting that its benefits extend beyond merely dressing a wound.

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Expanding the scope of NPWT's application, Suh et al. (Suh et al., 2015) investigate the effects of NPWT on closed incisional wounds with dead space, revealing that NPWT significantly reduces fluid accumulation and enhances skin perfusion and tensile strength. Their animal study provides a mechanistic foundation for NPWT's role in improving healing in complicated surgical contexts, thus reinforcing its clinical relevance.

The prospective randomized study by Pleger (Paul Pleger, 2017) builds on this foundation by examining the impact of closed incision management with NPWT on wound healing parameters. The findings indicate that NPWT can effectively reduce complications in high-risk surgical settings, including abdominal wall reconstruction and orthopedic surgery. This research highlights NPWT's versatility and effectiveness across various surgical disciplines.

Borejsza-Wysocki et al. (Borejsza-Wysocki et al., 2021) contribute to the discourse by evaluating NPWT's role in preventing surgical site infections (SSI) after stoma reversal. Their pilot study suggests that while NPWT may lower infection rates, the results must be interpreted with caution due to statistical insignificance. Nonetheless, they affirm NPWT's multifactorial mechanism of action, which promotes optimal healing conditions, thus emphasizing its potential utility in abdominal wound management.

The comprehensive review by Szabóné Révész et al. (Szabóné Révész et al., 2022) consolidates the findings on NPWT's effectiveness across a range of wound types and conditions, from acute to chronic wounds. Their analysis underscores the numerous advantages of NPWT, including enhanced blood flow and reduced bacterial load, which are critical for successful wound healing.

Finally, the systematic review by Wouters et al. (Wouters et al., 2022) and the study by Sato et al. (Sato et al., 2022) both reinforce the concept of prophylactic NPWT in preventing surgical site occurrences, particularly in high-risk surgeries such as ventral hernia repairs. Their collective findings support the growing body of

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evidence advocating for NPWT's integration into standard postoperative care protocols to mitigate complications such as SSIs and seromas.

This literature review, therefore, illustrates a compelling narrative surrounding the application of NPWT in closed laparotomy incisions, showcasing its evolving role in enhancing surgical outcomes and informing future clinical practices.

LITERATURE REVIEW

The article "Negative pressure wound therapy (NPWT) for spinal wounds: a systematic review" by Ousey et al. (Ousey et al., 2013) provides a comprehensive examination of the application of NPWT in managing closed surgical incisions, particularly in the context of spinal surgery. The authors highlight that while NPWT devices are beneficial in addressing surgical wounds at risk for post-operative complications, they do not supplant standard medical care. This assertion underscores the necessity for continuous wound surveillance to ensure optimal patient outcomes.

One of the key insights from the review is the delineation of pressure settings for NPWT, which the authors suggest should be tailored based on patient demographics and specific clinical circumstances. For instance, the recommended negative pressure settings vary significantly across age groups, with lower pressures (−50 to −75 mmHg) suggested for infants, and higher pressures (−100 to −125 mmHg) for adults. This nuanced approach to pressure application is critical, as it reflects the need for individualized patient care, particularly in populations with varying levels of vulnerability, such as the elderly or those on anticoagulant therapy.

The review also discusses the duration of NPWT application, noting a wide range of 4 to 186 days, which indicates variability in clinical practice and perhaps a lack of standardized protocols. This variability may influence healing times, which the authors report can range from 6 to 112 days. Such findings highlight the importance of further research to establish more definitive guidelines on NPWT duration and its impact on healing outcomes.

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Moreover, the article addresses practical concerns associated with NPWT, such as the issue of odour during treatment and the frequency of dressing changes. The authors point out that while manufacturers suggest NPWT dressings can remain in place for up to 7 days, clinical practice often sees changes occurring every 2 to 3 days. This discrepancy suggests a need for ongoing evaluation of NPWT protocols to enhance patient comfort and care.

Finally, the review touches on the cost-effectiveness of NPWT compared to traditional dressing methods. The authors suggest that NPWT may not only promote more effective wound healing but could also offer a cost-efficient alternative, which is a critical consideration in healthcare settings facing budget constraints.

The article titled "Application of negative pressure wound therapy in patients with wound dehiscence after abdominal open surgery: a single center experience" by 심홍진 et al. (et al., 2013) presents a focused examination of the use of negative pressure wound therapy (NPWT) in managing wound dehiscence following abdominal surgeries. The authors effectively contextualize NPWT, tracing its evolution from its introduction in the 1990s to its current applications in various surgical fields, particularly in abdominal surgery.

The study's retrospective analysis of 50 patients who underwent abdominal operations from November 2009 to May 2012 provides valuable insights into the effectiveness and complications associated with NPWT. Notably, the authors highlight that 60% of the patients were subjected to emergency surgeries, which underscores the challenging nature of the cases treated. The reported complication rate of 4% due to delayed wound healing suggests that while NPWT is generally effective, it is not without risks, particularly in a high-stakes surgical environment.

A critical evaluation of the methodology reveals that the retrospective nature of the study limits the ability to establish causation definitively. The reliance on computerized records may introduce biases related to data collection and patient

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selection. However, the authors compensate for these limitations by providing a clear and structured analysis of the outcomes associated with NPWT, emphasizing the positive results in terms of granulation tissue formation and overall recovery.

The conclusion drawn by the authors—that NPWT facilitates recovery in patients with wound dehiscence—aligns with the broader literature on the subject, reinforcing the therapy's role as a valuable tool in the postoperative management of abdominal wounds. The findings contribute to the understanding of NPWT's application in surgical contexts, particularly for patients experiencing complications like abdominal compartment syndrome.

The article "Negative pressure wound therapy for seroma prevention and surgical incision treatment in spinal fracture care" by Nordmeyer et al. (Nordmeyer et al., 2015) provides a comprehensive overview of the application of negative pressure wound therapy (NPWT) in the context of closed surgical wounds, particularly following spinal fractures. The authors detail the growing adoption of NPWT, specifically incisional NPWT (iNPWT), which has emerged as a promising intervention for enhancing wound healing and preventing complications such as seromas.

The article highlights the beneficial effects of iNPWT in the postoperative management of surgical incisions, particularly after severe trauma. The authors note that while the indications for iNPWT have expanded, the body of evidence supporting its efficacy remains limited, with a scarcity of prospective randomized studies. This raises important questions about the robustness of the findings and the need for further research to solidify the clinical guidelines surrounding iNPWT use.

Nordmeyer et al. (Nordmeyer et al., 2015) discuss the mechanisms through which iNPWT is believed to exert its effects, emphasizing enhanced tissue perfusion and increased oxygen delivery, which are thought to promote angiogenesis and facilitate healing. However, the authors candidly acknowledge that the precise mode of action of iNPWT is not fully understood, indicating a gap in the current knowledge base that warrants further investigation. This lack of clarity could potentially

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influence clinical decision-making and the standardization of NPWT protocols in surgical practice.

The article effectively underscores the importance of NPWT in modern surgical care, particularly in the context of preventing complications associated with closed laparotomy incisions. While the promising outcomes reported in the literature suggest that iNPWT may be beneficial, the authors call for more rigorous studies to validate these findings and to explore the underlying biological mechanisms at play.

The article "Negative Pressure Wound Therapy on Closed Surgical Wounds With Dead Space: Animal Study Using a Swine Model" by Hyunsuk Suh et al. (Suh et al., 2015) provides a comprehensive examination of the efficacy of negative pressure wound therapy (NPWT) in enhancing the healing of closed incisional wounds that are characterized by the presence of dead space. The authors highlight a significant clinical challenge in surgical practice, as closed incisional wounds often experience delayed healing due to the accumulation of fluid in the dead space beneath the repaired skin.

In their study, the authors conducted a controlled experiment involving bilateral incisional wounds created on the backs of six pigs. This animal model is particularly relevant as it closely mimics human skin characteristics and healing processes. The study design included two treatment groups: one receiving NPWT and the other receiving traditional gauze dressing. The application of NPWT over a period of seven days allowed for a direct comparison of its effects against a standard dressing method.

The findings presented in the article are compelling. The authors report that NPWT significantly reduces the amount of drainage from the wounds, which is a critical factor in preventing complications such as infection and delayed healing. Additionally, the study demonstrated that NPWT enhances blood perfusion to the skin, which is essential for effective healing as it delivers necessary nutrients and oxygen to the wound site. Furthermore, the increased tensile strength of the repaired

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skin observed in the NPWT group suggests that this therapy not only promotes healing but may also result in stronger wound closure, potentially reducing the risk of dehiscence.

The article effectively elucidates the mechanisms by which NPWT operates in closed incisional wounds with dead space. By creating a subatmospheric pressure environment, NPWT facilitates the removal of excess fluid, promotes granulation tissue formation, and enhances cellular proliferation, all of which contribute to improved wound healing outcomes. The authors argue that the application of NPWT in closed surgical wounds could be a valuable addition to surgical practice, particularly in general and colorectal surgery, where the risk of complications from incisional wounds is a significant concern.

The article "Wirkung der Closed Incision Negative Pressure Therapy auf inguinale Wunden nach gefäßchirurgischen Eingriffen: eine prospektiv randomisierte monozentrische klinische Studie" by Pleger (Paul Pleger, 2017) presents a thorough examination of the efficacy of Negative Pressure Wound Therapy (NPWT) in enhancing wound healing for closed surgical incisions, particularly within the context of general and colorectal surgery. The study underscores the significance of NPWT in mitigating complications commonly associated with surgical wounds, such as infections, which are critical considerations in postoperative care.

Pleger's research highlights that NPWT not only improves wound healing parameters but also plays a vital role in preventing surgical site infections (SSIs), especially among high-risk patients. This finding is particularly relevant for closed laparotomy incisions, where the risk of complications can be considerably elevated. The article presents compelling evidence that NPWT can be beneficial in large abdominal wall reconstructions, a procedure often fraught with challenges related to wound management.

The methodology employed in the study is noteworthy, as it employs a prospective randomized design, which strengthens the reliability of the findings. By focusing on inguinal wounds post-vascular surgical interventions, the research contributes to

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a growing body of literature that supports the use of NPWT across various surgical disciplines, including orthopaedic and abdominal surgeries. The outcomes reported suggest that NPWT is not only effective but also a promising adjunct in the surgical management of wounds, potentially leading to reduced rates of SSIs and improved patient outcomes.

However, while the study presents robust findings, it is essential to consider the broader implications of NPWT application. The variability in wound healing responses among different patient populations and surgical contexts may influence the generalizability of the results. Further research could enhance understanding of NPWT's effectiveness across diverse surgical settings and patient demographics. Additionally, long-term outcomes and cost-effectiveness analyses would provide valuable insights into the sustainability of NPWT as a standard practice in wound management.

The article titled "Effect of closed incision negative pressure wound therapy on incidence rate of surgical site infection after stoma reversal: a pilot study" by Borejsza-Wysocki et al. (Borejsza-Wysocki et al., 2021) presents a focused examination of the application of closed incision negative pressure wound therapy (ciNPWT) in the context of surgical site infections (SSIs) following stoma reversal procedures. The authors underscore the necessity of preoperatively assessing patient and procedure-dependent risks for developing SSIs, advocating for tailored strategies regarding wound closure and dressing selection.

A critical evaluation of the study reveals that while the outcomes suggest a trend towards lower postoperative wound infection rates in the ciNPWT group compared to traditional methods, the differences were not statistically significant. This finding raises questions about the robustness of the evidence supporting the routine use of ciNPWT in this specific surgical context. The authors acknowledge the variability in study design and the types of ciNPWT employed, which could significantly influence the results and their generalizability.

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The article effectively discusses the mechanisms through which NPWT operates, including the drainage of exudate, reduction of tissue edema, contraction of wound edges, stimulation of neoangiogenesis, enhanced granulation tissue formation, and increased blood flow to the surrounding tissue. These mechanisms are critical in creating an optimal healing environment, as they minimize the potential for fluid accumulation that could foster bacterial growth. The authors also highlight the benefits of NPWT in reducing scar thickness and improving the mechanical properties of the healed incision, which are important considerations in surgical recovery and long-term patient outcomes.

Furthermore, the introduction of NPWT for the prophylaxis of wound infection appears to correlate with a decreased risk of complications such as wound dehiscence and hematoma or seroma formation. This aspect of the study is particularly relevant as it aligns with the ongoing efforts to enhance postoperative care and reduce the burden of SSIs in surgical practice.

The article "Effectiveness of negative pressure wound therapy: Minimum five-year follow-up and review of the literature" by Szabóné Révész et al. (Szabóné Révész et al., 2022) presents a comprehensive evaluation of negative pressure wound therapy (NPWT) and its applications in wound management, particularly within the context of general and colorectal surgery. The authors highlight the multifaceted benefits of NPWT, which include enhanced local blood flow, reduced edema, and the promotion of granulation tissue formation. These factors are critical in the healing process, making NPWT a valuable tool for managing various wound types.

The study's emphasis on the long-term effectiveness of NPWT, with a follow-up of at least five years, provides significant insights into its sustained impact on wound healing outcomes. This longitudinal perspective is particularly valuable, as it allows for an assessment of NPWT's durability in clinical practice, which is often overlooked in shorter-term studies. The authors systematically review their patient database, illustrating NPWT's role in treating acute and chronic wounds, surgical dehiscence, pressure ulcers, and other complex wound scenarios.

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One of the article's strengths is its detailed exploration of the mechanisms by which NPWT facilitates healing. The authors discuss how NPWT not only reduces bacterial load but also aids in the removal of soluble wound healing inhibitors, thereby creating an optimal environment for healing. This mechanistic understanding is crucial for clinicians, as it underlines the importance of NPWT in preventing complications associated with wound healing, especially in high-risk surgical populations.

However, while the article presents a thorough review of NPWT's benefits, it could benefit from a more critical evaluation of potential limitations or contraindications associated with its use. For example, the authors do not extensively address the specific patient populations that may not respond favorably to NPWT or the situations in which its application may be inappropriate. Additionally, a discussion on cost-effectiveness and resource allocation in the context of NPWT would further enrich the analysis, particularly for healthcare systems aiming to optimize wound care strategies.

The article titled "The European Hernia Society Prehabilitation Project: A Systematic Review of Intra-Operative Prevention Strategies for Surgical Site Occurrences in Ventral Hernia Surgery" by Wouters et al. (Wouters et al., 2022) provides a comprehensive examination of the efficacy of negative pressure wound therapy (NPWT) as a preventative measure against surgical site occurrences (SSOs) in the context of ventral hernia surgery. The authors systematically review existing literature, identifying eight studies that specifically focus on the prophylactic application of incisional NPWT following ventral hernia repair.

A critical insight from the article is the strong consensus among the reviewed studies regarding the beneficial impact of NPWT on reducing both surgical site infections (SSIs) and SSOs. For instance, Soares et al. (as cited in Wouters et al. (Wouters et al., 2022)) demonstrated a significant drop in SSI rates from 32% to 9% and in SSO rates from 42% to 17% when NPWT was employed. Similarly, De Vries et al. provided evidence of a marked decrease in postoperative wound

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infection rates among high-risk patients undergoing major ventral hernia repair when NPWT was utilized. The findings from Bueno-Lledo also reinforced these results, showing a reduction in SSOs from 29.8% to 16.6%, with a notable absence of SSIs in the NPWT group compared to an 8% rate in the control group.

The systematic review effectively highlights the potential of NPWT as a standard practice in surgical settings, particularly for patients undergoing high-risk procedures such as ventral hernia repair. However, while the evidence presented is compelling, it is essential to consider the limitations inherent in the studies reviewed. The sample sizes, although significant, vary, and the specific contexts of each study could influence the generalizability of the results. Furthermore, the authors do not delve deeply into the mechanisms by which NPWT exerts its beneficial effects, which could provide a more robust understanding of its application in surgical practice.

The article "Efficacy of Prophylactic Negative-Pressure Wound Therapy with Delayed Primary Closure for Contaminated Abdominal Wounds" by Sato et al. (Sato et al., 2022) provides significant insights into the application of negative pressure wound therapy (NPWT) in the context of contaminated abdominal wounds, particularly emphasizing its role in reducing the incidence of surgical site infections (SSIs). The authors present a compelling argument for the use of open NPWT combined with delayed primary closure (DPC) as a viable treatment strategy for contaminated and dirty/infected surgical wounds.

One of the key strengths of this study is its focus on the clinical outcomes associated with NPWT in a single-arm, noncomparative design. While the lack of a comparative control group limits the ability to draw definitive conclusions regarding the cost-effectiveness of NPWT, the authors effectively highlight the safety and efficacy of this method in treating severely contaminated wounds. This is particularly relevant for general and colorectal surgery, where the risk of incisional SSIs can be significantly heightened due to the nature of the procedures involved.

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The findings suggest that NPWT, when applied for at least seven days, can contribute to a reduction in the incidence of incisional SSIs. This is particularly important for surgical teams aiming to enhance patient outcomes and minimize postoperative complications. The study's conclusions resonate with the growing body of literature advocating for NPWT as a preventive measure in high-risk surgical scenarios.

However, the article could benefit from a more thorough discussion of the limitations inherent in its design. The absence of a control group raises questions about the generalizability of the results and the potential influence of confounding variables. Additionally, the authors do not explore the long-term implications of NPWT on wound healing and patient recovery, which could provide a more comprehensive understanding of its effectiveness.

CONCLUSION

The literature on Negative Pressure Wound Therapy (NPWT) for closed laparotomy incisions in general and colorectal surgery reveals a significant advancement in understanding its efficacy and applications over the past decade. Several studies and reviews collectively underscore the potential of NPWT to improve postoperative outcomes by promoting wound healing, reducing complications, and enhancing patient recovery.

(Ousey et al., 2013) provide a foundational overview of NPWT devices, emphasizing their role in complementing standard medical care rather than replacing it. They advocate for a tailored approach to NPWT application, with optimal pressure settings varying according to patient demographics and clinical conditions. This individualized strategy is crucial for maximizing the benefits of NPWT in diverse surgical populations.

Supporting this notion, (et al., 2013) present empirical evidence regarding NPWT's effectiveness in managing wound dehiscence after abdominal surgeries. Their findings indicate that NPWT fosters granulation tissue formation and expedites

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recovery, particularly among high-risk surgical patients. This aligns with the overarching theme of NPWT's utility in complex surgical settings.

(Nordmeyer et al., 2015) expand the discussion by focusing on incisional NPWT (iNPWT) and its application in closed surgical wounds. They note promising outcomes related to tissue perfusion and angiogenesis, suggesting that NPWT's mechanisms may extend beyond mere wound dressing, thereby enhancing healing processes.

(Suh et al., 2015) further investigate NPWT's effects on closed incisional wounds characterized by dead space. Their animal study demonstrates that NPWT significantly reduces fluid accumulation and improves skin perfusion and tensile strength, reinforcing NPWT's clinical relevance in complicated surgical scenarios.

(Paul Pleger, 2017) contributes to the discourse by highlighting NPWT's role in reducing complications across various surgical disciplines, including abdominal wall reconstruction. This prospective randomized study affirms NPWT's versatility and effectiveness, particularly in high-risk surgical settings.

(Borejsza-Wysocki et al., 2021) evaluate NPWT's impact on preventing surgical site infections (SSIs) after stoma reversal, suggesting that while NPWT may lower infection rates, results must be interpreted with caution due to statistical insignificance. Nonetheless, they emphasize NPWT's multifactorial mechanism of action in promoting optimal healing conditions.

(Szabóné Révész et al., 2022) consolidate findings on NPWT's effectiveness across a range of wound types, highlighting its advantages such as enhanced blood flow and reduced bacterial load, critical factors for successful wound healing.

(Wouters et al., 2022) and (Sato et al., 2022) reinforce the concept of prophylactic NPWT in preventing surgical site occurrences, particularly in high-risk surgeries. Their collective findings advocate for NPWT's integration into standard postoperative care protocols, aiming to mitigate complications like SSIs and seromas.

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In conclusion, the body of literature presents a compelling case for the application of NPWT in closed laparotomy incisions, emphasizing its evolving role in enhancing surgical outcomes. The evidence suggests that NPWT not only improves wound healing but also serves as a proactive measure in preventing complications, thereby informing future clinical practices in general and colorectal surgery.

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